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Proceedings Series 2001/07 | Série des compte rendus 2001/07

Proceedings of the National Marine Mammal Review Committee

Feb. 27 - March 2, 2001
Freshwater Institute
Manitoba

John D. Neilson, Chairperson

Canadian Stock Assessment Secretariat
200 Kent, Ottawa
Ontario, K1A 0E6

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ABSTRACT

The National Marine Mammal Review Committee (an entity of the Canadian Stock Assessment Secretariat) met at the Freshwater Institute, Winnipeg, February 27 to March 2. Agenda items included the stock structure of killer whales in British Columbia waters, an evaluation of the methodology used in the enumeration of Steller Sea Lions and an update on population trends, and a review of the methodology used in surveys of St. Lawrence beluga whales. A main theme of the meeting was an evaluation of the status of Eastern Hudson Bay beluga whales, and a series of working papers was reviewed pertaining to the stock structure, harvest and population status. A stock status report describing key conclusions of the review was prepared.

Apart from reviewing the above work, the NMMRC also discussed recent research conducted by its members, including processing of ARGOS satellite data, grey seal diet studies as inferred from fatty acid signatures and procedures for survey design.

RÉSUMÉ

Le Comité national des mammifères marins (une division du Secrétariat canadien pour l'évaluation des stocks) s'est réuni du 27 février au 2 mars à l'Institut des eaux douces (Winnipeg). L'ordre du jour comprenait la structure du stock d'orques dans les eaux de la Colombie-Britannique, une évaluation de la méthode de dénombrement des lions de mer de Steller ainsi qu'une mise à jour sur leurs tendances démographiques, et une revue de la méthode utilisée dans les relevés sur les bélugas du fleuve Saint-Laurent. Un item important de la réunion fut l'évaluation de l'état des bélugas de l'est de la baie d'Hudson, et la revue d'une série de documents de travail se rapportant à la structure des stocks, aux captures et à l'état de la population de ces mammifères marins. Un rapport sur l'état de ce stock fut rédigé, exposant les grandes conclusions de la revue.

Mis à part la revue des travaux susmentionnés, le Comité national des mammifères marins a aussi discuté des dernières recherches effectuées par ses membres, y compris le traitement des données obtenues du système satellitaire ARGOS, les études sur le régime du phoque gris tel que déduit des signatures d'acides gras et les procédures pour la conception du relevé.

OPENING REMARKS

The Chairman welcomed participants (Annex 1). He gave a brief presentation describing the meeting procedures, and the documentation requirements. The list of working papers and their terms of reference (Annex 2) and agenda (Annex 3) were reviewed and adopted. The Chairman noted that there was good geographic representation at the meeting. He also welcomed three external reviewers to the meeting (Dr. Andrew Trites (University of British Columbia), Dr. Robert Michaud (Groupe de Recherche et d'Education sur les mammireres marins) and Dr. Ted Miller (Memorial University). Dr. Michael Kingsley (Greenland Institute of Natural Resources, Nuuk), although not able to attend in person, kindly provided remarks on several of the working papers presented here. Client representatives attending the meeting included Ms. Okalik Eegiasiak (Nunavut Wildlife Management Board), Dr. Burton Ayles (Fisheries Joint Management Committee, Inuvialuit Joint Secretariat) and Dr. Bill Doidge (Makivik Corporation).

REVIEW OF WORKING PAPERS

Day 1 Morning Discussions

1. **Population Structure and Genetic Variability in Northeastern Pacific Killer Whales: Towards an Assessment of Population Viability. By L. G. Barrett-Lennard and G. M. Ellis. Working Paper #1.**

   Presenter: Lance Barrett-Lennard
   Rapporteur: Rob Stewart

   Summary: (The summaries are provided by the authors, and have been revised to reflect the review committee's comments)

Long term studies of killer whales (*Orcinus orca*) in the coastal waters of British Columbia have identified two sympatric non-associating populations: fish-eating *residents* and mammal-eating *transients.* A third group, the *offshores*, frequents the outer continental shelf. The resident population contains two regional subpopulations in British Columbia and is currently listed as threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). In Alaska one additional putative subpopulation of residents and two of transients have been reported. This complex of populations and subpopulations persisting in the absence of obvious dispersal barriers presents a problem to conservation managers who must decide whether subpopulations should be assessed separately or in combination. Clearly, the decisions should rest on an understanding of the discreteness of the subpopulations. Here, we report a molecular study designed to contribute to such an understanding. This study a) characterized each known subpopulation of killer whales genetically, b) compared genetic variability between the subpopulations and c) analysed mating patterns within the resident subpopulations to determine inbreeding levels.

Lightweight pneumatic darts were used to take biopsy samples from 269 individually-identified killer whales off British Columbia and Alaska. Nuclear DNA from the samples was typed at 11 polymorphic microsatellite loci, and the entire mitochondrial D-loop was sequenced. The results were used to construct population phylogenies, assess genetic diversity, calculate fixation indices (*F*-statistics), and conduct paternity analyses. The following findings were key: 1) resident and transient killer whales are reproductively isolated, 2) the division of each into three regional subpopulations is supported genetically, 3) offshores are genetically differentiated from all known resident and transient subpopulations, 4) residents have lower levels of genetic variation than transients, 5) the observation from field studies that residents remain in their natal groups for life is typical of the recent history of the population, 6) despite their lack of permanent dispersal, residents mate outside their natal groups.

One transient subpopulation (the critically endangered *AT1* population of Alaska) appears to be genetically isolated from all other subpopulations. Permanent dispersal between the remaining two transient subpopulations is very rare or non-existent, but gene flow mediated by occasional intermatings could not be ruled out. In the resident population, occasional matings of individuals from different subpopulations could not be ruled out. However, if such intermatings occur, they are most common between the *northern residents* (which inhabit central and northern British Columbian waters) and the *southern Alaskan residents*. Our

findings are consistent with the complete genetic isolation of the southern resident population of British Columbia. This subpopulation is of conservation concern because of it small size (less than 85 individuals), a recent decline, and high contaminant loads.

Paternity analysis showed that resident killer whales have strong (presumably behavioural) inbreeding avoidance mechanisms. In all but one instance, pod members were excluded as possible fathers of calves. In the northern resident community, the majority of matings were between individuals from pods belonging to different "acoustic clans". No paternity matches were made between southern residents and members of the other two resident subpopulations, however, there were several possible matches between the latter two populations.

We recommend that three resident subpopulations, three transient subpopulations, and the offshore population should be recognized as separate stocks or management units for conservation purposes in British Columbia and Alaska.

Discussion:

The paper was augmented by a useful primer in killer whale biology to familiarize attendees from other coasts. There was a general discussion, and the basic conclusions of the paper were accepted. Most of the discussion provided editorial comments and suggestions directed at clarifying the paper.

Possible biases have been addressed by the authors. There was some concern expressed about the relatively small sample sizes for some populations although the group accepted the argument that the statistical analyses used were robust to these small samples.

There was some criticism raised that these genetic groups could not be translated into clear management units. The group was reassured that instead of being genetic groups within an otherwise homogeneous population, they were identifiable groups that had now been shown to have genetic differences. It was also noted that enough was known about the biology of the identifiable groups to be able to target management actions for one group or another.

The consequences of low genetic variability may be an increased vulnerability to other hazards (e.g., chemical pollution). It was noted that the effective population size might be very small in some groups, and although the impact of low genetic diversity on subpopulations could not be determined at present, the paper should be enlarge on possible effects.

The group recommended that this paper be upgraded to a Research Document.

The low haplotype diversity in at least two subpopulations (the offshore and southern resident subpopulations) may be an artifact of small sample sizes. It is recommended that priority should be placed on acquiring and analysing more samples from these groups.

Day 1 Afternoon Discussions

2. Stock discrimination of belugas (*Delphinapterus leucas*) from Sanikiluaq (Belcher Islands) and Eastern Hudson Bay using mitochondrial DNA and 15 nuclear microsatellite loci. By: B.G.E. de March, L.D. Maiers, M.O. Hammill, and D.W. Doidge. Working Paper #2.

Presenter: Brigitte de March
Rapporteur: Don Bowen

Summary:

We examined the possibility that the community of Sanikiluaq on the Belcher Islands, Nunavut, Canada, hunts the COSEWIC threatened stock of eastern Hudson Bay (EHB) beluga, Québec, Canada. The molecular genetics of 95 belugas hunted from Sanikiluaq, 100 from communities in EHB, and 399 from other geographic areas which might share stocks or are known to be genetically similar were examined. Individuals and sample populations were characterized with a mitochondrial DNA (mtDNA) d-loop sequence of 324 base pairs which described 32 (maternally inherited) different haplotypes and also with 15 nuclear microsatellite loci (inherited from both parents) which had an average of 12.6 alleles/locus.

Belugas from several of the examined populations may interbreed and thus stock definition comes primarily from different mixtures of haplotypes. There is considerable genetic overlap among all populations examined. Results generally support the hypotheses that EHB and Sanikiluaq belugas are different stocks. Although microsatellite do not distinguish populations well, it is possible that EHB belugas breed with western population that do not include Sanikiluaq, and Sanikiluaq belugas may breed with stocks hunted in Northern Hudson Bay.

Belugas from both the Nastapoka River (1984-1995) and the EHB arc (1993-1997) are characterized by high proportions of two haplotypes. Differences persisted over many years. Belugas from the Nastapoka River have several haplotypes that were not found elsewhere, and also a low haplotype and microsatellite diversity. Belugas sampled from other locations in EHB arc in the1990s have these same haplotypes, but also a low frequency of western haplotypes. The belugas that were sampled later also have a slightly higher microsatellite diversity. 16% of belugas hunted in EHB have genotypes that resemble western populations.

The genetic composition of belugas hunted in Sanikiluaq over five years was very consistent. These belugas had a high haplotypes and microsatellite diversity, however proportions differed from other western Hudson Bay populations. However, it is possible that a consistent mixture of stocks is hunted at Sanikiluaq. Beluga males from Sanikiluaq may have a slightly higher genetic diversity than females. Approximately 10% of belugas hunted from Sanikiluaq resemble EHB genotypes.

Since genetic characteristics overlap among the populations we examined, it was impossible to distinguish belugas that were outside of their summering range and those that had genetic characteristics more typical of other populations. In the extreme case, up to 30% of belugas hunted in northern Québec may be EHB belugas, up to 20% in northern Hudson Bay, and 7% in Kimmirut. Different stocks may be hunted in different locations and years.

Belugas from the Churchill, Nastapoka, and St. Lawrence Rivers have low genetic diversities. This may be a characteristic of river populations and/or may be due to overhunting in the past.

Some genetic patterns described can be explained by post-glacial dispersion. This is evidence of the extremely strong philopatric behaviour of belugas.

Discussion:

There was a general comment that it might be useful to calculate a weighted probability of assignment of individuals to areas given that sample sizes are quite variable among sampling sites (see Fig. 3.2.). It was agreed that this approach could be taken, but that it was unlikely that such calculations would change the overall conclusions.

There was a question about the impact of extending the number of base pairs in the analysis on the conclusions about population structure. Although, initially the use of a larger section of genetic material seemed to offer additional insight into population structure by the detection of additional haplotypes, it may turn out that the addition of a large number of rare haplotypes will complicate the statistical analysis of the data without providing further insight. Nevertheless, it is too early to draw final conclusions in this regard.

A question was asked concerning how the assignment probabilities of individuals to putative populations were calculated? The haplotypes were assigned to population where its expected frequency (i.e., probability) is highest. There was also some discussion as to how estimates of the probability of incorrect assignment could be used. As there are three estimates of the assignment probability for each individual, one associated with each population, it is likely that mis-assignment probabilities are important and therefore should be investigated. It is also likely that assignment probabilities could be improved by accounting for the fact that the next best probability was often close to the chosen probability. This is being investigated further by the senior author.

The sampling location of some samples used in the genetic analysis was not known. This does not affect the current conclusions, but better data on the spatial and temporal distribution of samples will be needed to refine the analysis. Hunters record the location of harvest on their logs, but the location is not always provided in summary reports provided to researchers. There is a project underway to capture this information in a geo-referenced format, which will address this problem.

An important conclusion of this study is that the whales harvested from Sanikiluaq may represent a separate stock. However, this conclusion should be viewed as a hypothesis to be tested with additional data rather than a firm conclusion. One reason for this is that samples from some of the major concentrations of whales in James Bay and the eastern Arctic are lacking. These locations must be sampled before the status of the whales harvested from Sanikiluaq can be determined with certainty.

Research recommendation -

To better understand the genetic structure of the beluga populations in the Eastern Hudson Bay, more samples should be collected from areas such as N.E. Hudson Bay, James Bay, Hudson Bay rivers and Hudson Strait, where samples sizes are small.

B. De March – Clarification pertaining to the identity of the animals found around the Belcher Islands during summer (supplemental analyses presented Friday AM)

The new information presented on dates of harvests vs haplotypes and microsatellites indicate that at least a few individuals taken by Sanikiluaq each summer probably belong to the EHB stock. On that basis, there was a general agreement that the high probability that not only EHB animals are counted as part of eastern Hudson Bay aerial surveys should be acknowledged in the stock status report.

It was also suggested that the effect of a change in the relative weighting of haplotypes vs microsatellites results on the conclusions about the probability of association of an individual to one stock or the other be examined.

The paper was recommended to be upgraded to a Research Document.

3. Harvest Statistics for Beluga Whales in Nunavik, 1974-2000. By: Véronique Lesage, D. William Doidge, and Robert Fibich. Working Paper #3.

Presenter: Véronique Lesage
Rapporteur: Don Bowen

Summary:

The Nunavik communities have traditionally hunted beluga along the eastern Hudson Bay, Hudson Strait and Ungava Bay coasts of northern Quebec. Catch levels by these communities have been monitored over the last twenty-six years, and this report summarizes available information on these statistics from 1974 to 2000. Between 1974 and 1986, an average of 243 beluga were harvested annually by the four Hudson Strait communities, whereas 124 and 83 animals were harvested by eastern Hudson Bay (N = 3), and Ungava Bay communities (N = 5), respectively. During that period, a decline in beluga harvests was observed in each region, and in several communities, although it occurred later in eastern Hudson Bay (*i.e.* 1981) than in Hudson Strait and Ungava Bay (*i.e.* 1978). The location of harvest, some biological samples, and the age, sex and colour composition of catches were provided by hunters for beluga harvested during 1993—2000. Beluga are harvested principally during summer by the south-eastern Hudson Bay communities (*i.e.* Kuujjuaraapik, Umiujaq, and Inujjuaq), and during October by the north-eastern Hudson Bay communities (*i.e.* Akulivik and Puvirnituq). Hudson Strait communities harvest beluga in the fall and spring when animals move in and out of the Strait. Ungava Bay communities tend to follow the same pattern since the imposition, in 1986, of restrictions on beluga harvests in Ungava Bay. In recent years, Akulivik and Puvirnituq tend to harvest part, or most, of their quota from the Ivujivik area in south-western Hudson Strait, while Ungava Bay communities harvested beluga both from the Ungava Bay and the Quartaq area, in south-eastern Hudson Strait.

Depending on region, grey beluga represented 46 to 51% of harvests, and females, 47 to 60% of catches during 1993–2000. The proportion of white males (23—30%) in harvests

was near the percentage expected if animals were taken at random (*i.e.* 25%) during 1995—2000, even thus management plans recommended that harvesting be directed towards white males.

A comparison of the age frequency distributions of beluga harvested during the mid-1980s and the 1990s, indicates a recent, statistically significant change in the age composition of the harvest. During 1980–1987, the median age of beluga taken by the Nunavik communities was 14 yrs, whereas this value decreased to 9 yrs during 1993–1999. This tendency was even more pronounced for the three southernmost communities of eastern Hudson Bay and the communities from Ungava Bay, with median ages of 8.0 yrs and 8.5 yrs, respectively. The beluga harvested during October in south-western Hudson Strait by Puvirnituq were also relatively young, with 50% of the animals being aged ≤ 7.5 yrs (but N = 13).

Discussion:

The discussion of harvest statistics centered on apparent changes in the age distribution of the harvests that have been observed between the 1980s and 1990s. Several issues were raised. First, given that different people determined the ages of the different samples, could the apparent difference be an artifact of differences in the interpretation of growth layer groups in the teeth. This seemed unlikely as care was taken to ensure comparability of ages through training. It was also pointed out that tooth-wear in older whales meant that the ages of older whales are minimum ages only. It was noted that the proportion of worn to non-worn teeth declined to 20% in the 1990s sample from 44% in the 1980s sample. This decrease is consistent with the interpretation that the more recent harvests comprised younger animals. Thus, differences in age determination are unlikely to have a significant effect on the estimated age distributions.

Another concern was that the differences in age distributions might have arisen from changes in the way the hunt is conducted. Several sources of bias were discussed. Selectivity may vary with the number of whales available to hunters. Age and sex classes do have different patterns of associated and meso-scale distribution. This could also be a source of bias, but the extent of bias has not been investigated. Also, the sample of aged whales may not be representative of the total harvest. This could be tested by calculating the fraction of aged whales by community and investigating if these proportions have changed over time. Changes in the seasonal distribution of the harvest might also have changed the availability of different aged whales to hunters. However, there appears to have been little change in the seasonal distribution of the harvest. On the other hand, there appears to have been a change in the age and hunting patterns of the hunters. Hunters are younger and there are more weekend hunters. Just how such changes may have affected the age structure of the harvest is uncertain, but these changes should be investigated further. Finally, changes in hunting effort might also shed light on the causes of the change in the age structure of the harvest? There are two types of hunts: those that occur when whales return to estuaries and those that occur opportunistically along coastal areas. However, in both types of hunts there appears to be no obvious way to measure hunting effort in a consistent way over time.

There were several suggestions for further analysis of the age structures of the harvest that might provide addition insight on the underlying causes of the observed changes. One suggestion was to consider shorter time blocks in the analysis to determine how the age

structure of the harvest has changed over time. Also, a separate analysis of the estuary and coastal harvests might be informative, as the biases associated with these hunts should differ. Finally, it was suggested that further analysis of the proportion of white males in the harvest should be compared before and after the 1996 management action designed to encourage the hunting of large males. If the proportion of white males declined after 1996 this would support the hypothesis that the change in median age of animals harvested reflected an underlying change in the population and not a change in hunting practices.
The discussion then turned to the accuracy of the harvest statistics. Harvest statistics are derived from summary reports of community agents. These reports summarize the total and monthly harvests by community. A concern is that there are cases where the monthly and total harvests for a community are not consistent. Clearly, this needs to be sorted out before the harvest statistics for such communities can be accepted with confidence. In addition to the reports of community agents, the biological sampling program operated through the DFO also provide data on the numbers of whales harvested. However, some communities do not participate in the sampling program and so for the most part the reports of community agents are used. A further limitation of these reports is that there is no way to estimate if there is unreported kills, although since 1991 some struck and loss reports are made, but again not from all communities. Although there are uncertainties about the extent of whales struck but not recovered, harpoon harvests likely have very low incidence of struck and loss. In areas like the Hudson Strait where harpoons are not used, the incidence of struck and loss is not known.

Recommendations

The committee recommends that the incidence of struck and loss be estimated for the Hudson Strait harvests.

Examine the median ages of white males over time, as well as the proportion of worn teeth, to further understand the cause of the change in the age structure of the harvest over time.

V. Lesage et al., Harvest statistics of beluga whales by the Nunavik communities 1974-2000. *(supplemental analysis presented Wednesday)*

In response to questions raised on Tuesday, Véronique Lesage broke down the 1990s kill data by year and area. The data showed that the mean age of belugas killed in Hudson Strait and Ungava Bay has declined since the 1980s. The pooled 1980s samples still need to be analyzed by year. The data also have to be partitioned by areas and types of hunting (i.e., river versus open water). Another approach that should also be explored to assess whether mean age has declined is to calculate the mean ages of an unambiguous class, such as white males and females, by year of kill. Further analyses of the kill statistics are still required to fully understand the apparent change in mean age of belugas killed since the 1980s.

This document was recommended to be upgraded to a research document.

Day 2 – Morning Discussions

4. Use of Nastapoka Estuary by humans and belugas during summer 2000. By D. William Doidge.

Presenter: Bill Doidge
Rapporteur: Patrice Simon

Summary:

The use of the Nastapoka Estuary, eastern Hudson Bay (57° 47'N 76° 32'W), by beluga whales, *Delphinapterus leucas*, and humans was documented over a 24 day period (July 29 – August 22, 2000) through land-based observations. Vessel traffic, mainly freighter canoes, occurred in or near the estuary 140 times during the study. Of these, 67% were Inuit who had come to the river to hunt, fish or travel along the coast; 21% were by the observation team (usually following other disturbances); 7% were by Cree from Great Whale River who were hunting caribou; 2% were due to tourism and 2% from government fisheries patrols. Whales were sighted on 9 of the 24 days compared to the almost daily appearances recorded by other studies in the 1980s. A maximum of 61 whales was seen at any one time compared to <250 in the 1980s. Re-analysis of published studies show no difference in the duration-of-absence after hunts or disturbance by motor traffic. Duration-of-absence has increased from 19.8 ± 13.6 hrs (n=16) in 1984 to 30.5 ± 30.9 hrs (n=9) in 2000. This may indicate that whales are avoiding the estuary due to increased disturbance by motor traffic, or that the stock has been depleted. The importance of estuaries to beluga whales is still uncertain.

Discussion:

It was suggested that the author looks at the possibility of habituation by belugas that were identifiable and observed on several occasions (N1, N3, N8, N10) to examine if there was a consistent decline in the return time to the estuary. Does their absence from the estuaries get shorter after several disturbances? Raw data from Louise Caron's work should be examined to see if enough data are available. If the data allow, it would be interesting to look at the difference between the two types of disturbance recorded: hunting versus boat traffic only. It was noted that, in places where there is no hunting, boat traffic does not appear to disturb beluga, so hunting is likely to have an important impact on their behavior. One recommendation from the group was to compare the effect of disturbance between populations that are hunted and the one that are not in a given area.

Data from Caron could be examined to see if there is enough information to look at absence of individual beluga rather than beluga in general. It was noted that it is important to know if the belugas that are coming back are the same individuals that were disturbed. Disturbance effects should be investigated for individuals rather than by presence/absence of whale only.

It was also noted that large populations are sometimes more tolerant to disturbance than smaller ones. A. Trites will provide references to the author for populations/species where such conclusions were reached. However, it may be difficult to relate disturbance effect on presence in estuaries and changes in stock size.

There were some discussions about the importance of estuarine habitat to beluga. Some argued that it must be very important to at least some individuals as they persist in returning after disturbance. However, we have very little information about the relative use/importance of offshore habitat.

From the discussion of the presentation, three main points emerged: 1) boat traffic (or human-caused disturbance) has increased from 1983-84 to 2000 in the Nastapoka estuary. 2) there is less beluga in the Nastapoka estuary, and 3) belugas leave the estuaries if a boat enter it. However, it was concluded that it is difficult to relate change in stock size to change in beluga numbers at the estuary.

It was also noted that there might be a bias in identifiable beluga toward older individuals, as they are more likely to have scars or notches on the dorsal ridge.

It was suggested to investigate noise propagation in the estuary to describe better the degree and intensity of the disturbance (boat traffic).

This document will be presented to Environment Canada for the Species at Risk Program.

5. Implications of Different Estimates of Longevity of Belugas and Narwhals on Sustainability. By P. Richard. Working Paper #5.

Presenter: Pierre Richard
Rapporteur: Patrice Simon

Summary:

Questions have recently been raised on the validity of the use of two dentinal growth-layer-groups to age belugas. In this analysis we sought to determine if using such an assumption might lead to management decisions that are not sustainable. Comparisons of age structure which might result from one or two growth layers suggest that the two growth layer assumption is conservative.

Discussion:

The author presented the results of modeling done to investigate the impact of the assumption of the 2 growth-layer-group (GLG) used in ageing belugas. He presented two age-specific survival curves, one for the 2 GLG model and one for the 1 GLG model.

It was noted that differences between a 1 GLG and 2 GLG model could result from either a decrease in r_{max}/productivity, or an increase in juvenile mortality, for which there are no empirical data. It was therefore recommended that the author investigate the impact of 1 GLG versus 2 GLG by using populations of *Tursiops* or killer whales for which estimates of survivorship are available. It was therefore recommended that the author investigate the impact of 1 GLG versus 2 GLG by using populations of *Tursiops* or killer whales for which estimates of survivorship are available.

The participants agreed with the conclusion that the model provides evidence that using the assumption of 2 GLG is a more conservative assumption than using the 1GLG. The first

sentence of the last paragraph of the discussion section should be deleted. The word "precautionary" in the last paragraph should be changed to "conservative".

There was some criticisms raised about the survivorship values used for juvenile belugas. Also, the author should not use the maximum longevity recorded in the model but rather 95% of maximum age.

There was a mistake identified in the text. The rates of increase for 1 GLG and 2 GLG were interchanged.

There were discussions about the low juvenile survival rate used in the model. Killer whales and *Tursiops* have a much lower juvenile survival rate and it is likely that juvenile belugas have similar survival rate. However, the author noted that this was a theoretical exercise and that some assumptions, although not probable, were necessary to arrive at the double longevity of 1GLG.

This document will be upgraded to a research document at the author's discretion.

Day 2 – afternoon

6. **Eastern Hudson Bay Beluga Precautionary Approach Case Study: Risk Analysis Models for Comanagement. By P.R. Richard, M. Power, M. Hammill and D.W. Doidge. Working Paper #6.**

   Presenter: P.R. Richard
   Rapporteur: Andrew Trites

   Summary:

This case study attempted to develop modelling tools that would be useful in a co-management setting to develop a precautionary approach for the Eastern Hudson Bay beluga population. We developed and tested a stage-structured stochastic model that allowed the projection of population size over time given the uncertainty of population size and dynamics, and given management options involving a choice of hunting mortality and gender or age- (stage-) ratio of the catch. Uncertainty in initial population size was the single most important parameter in determining the uncertainty of projected population size over time. Projections were made over a period of 30 years. Risk was evaluated based on whether the population declined at any time during that period. Model runs showed that risk of decline was high if the population suffered hunt mortality in excess of a few tens of animals per year but a male-biased catch lessened this risk. At low population size, density dependence did not appear to matter to the risk probabilities.

Discussion:

There was general agreement that the choice of modeling software and general modeling approach was appropriate for assessing the possible risks and population consequences of harvesting Eastern Hudson Bay beluga whales at different levels. This approach would be useful for other Arctic populations of beluga whales. Of all parameters used, the model predictions were most sensitive to uncertainty in the numbers of beluga whales believed to be present. Model predictions were relatively insensitive to uncertainty in stage survival

rates, the proportion of whales near the surface, the estuary count and fecundity estimates. These results suggest that greater effort should be spent on refining estimates of population size.

A number of changes were suggested that will be considered in future runs of the model. These included:

- Assessing the sensitivity of model predictions to the duration of life history stages that are currently set at 1, 5, 16 and 17 years.
- Running the model with initial conditions that are more in line with actual population estimates and numbers killed.
- Running the model so that it reflects uncertainty in the age distribution, numbers, and sex of whales killed.

There was also consensus that further thought should be given about the reliability of using survival rates drawn from longitudinal studies of killer whales and bottlenose dolphins. These estimates do not account for mortality that occurs between the time calves are born and the first time that researchers see them. Thus, survival rates taken from killer whales for this stage of beluga life may be too high (perhaps by a factor of 2).

This document was recommended to be upgraded to a research document.

7. Population Index Estimate for the Belugas of the St. Lawrence in 2000. By J.-F. Gosselin, V. Lesage and A. Robillard. Working Paper #7.

Presenter: Jean-François Gosselin
Rapporteur: Andrew Trites

Summary:

Abundance of beluga in the St Lawrence estuary was estimated from an aerial survey flown on 28 August 2000. Two fixed-wing aircraft equipped with 9"x9" format mapping cameras flew 52 strip transects across the Estuary between Baie St-Paul and Rimouski for a total survey coverage of 49.3%. A visual survey to count beluga in the Saguenay River was flown at the same time. In the estuary, 453 (SE = 54) beluga were estimated to be at the surface between Kamouraska and Les Escoumins after correction for sun glare, and 6 beluga were counted downstream of Baie Ste-Marguerite in the Saguenay River. A 15% correction factor was applied to the estimated number of beluga in the estuary to account for beluga missed because they were underwater. Adding the Saguenay River count to the corrected estimates resulted in an index count of 527 (SE = 62). This corrected index used in trend analysis along with 5 equivalent survey indices obtained between 1988 and 1997, revealed no significant changes in abundance of beluga in the St Lawrence estuary since 1988.

Discussion:

The methodology used in 2000 to estimate the numbers of beluga whales in the St. Lawrence was considered to be good and does not need revision. The estimate of 527 beluga whales (SE=62) is considered to be reliable.

Suggestions on improving the manuscript included removing the regression line from Fig. 5 and clearly identifying the best estimates of population size in Table 2.

There was no discernable trend in population numbers of beluga in the St. Lawrence from 1988 to 2000. Nor was any discernable trend detected in numbers of dead belugas recovered from the St. Lawrence River. A figure showing numbers of dead beluga whales recovered should be included in the paper.

Future analyses should explore the use of other statistical techniques (such as Bayesian or maximum likelihood techniques) to estimate population trends. Power analyses or some similar technique should also be used to determine how many years of surveying would be required to detect 1 or 2% changes in numbers given the clumped distributions and small sizes of beluga populations. This is particularly important given that there may not be enough data yet to know with confidence whether beluga numbers are actually stable in the St. Lawrence. Effort should also be spent gathering additional population data, most notably birth and survival rates.

This document was recommended to be upgraded to a research document.

Day 3 – Morning

8. **Beluga in Northern Quebec: Impacts of Harvesting on Population Trends of Beluga in Eastern Hudson Bay and James Bay. By M.O. Hammill. Working Paper #8.**

   Presenter: M.O. Hammill
   Rapporteur: Lance Barrett-Lennard

   Summary:

A five-year management plan implemented in 1995 limited beluga harvests to 90 animals by hunters from eastern Hudson Bay communities, 100 beluga by communities in Hudson Strait and 50 animals by communities in Ungava Bay as long as harvesting occurs outside of the bay. However, throughout the plan harvesting by Hudson Strait and Hudson Bay communities consistently exceeded the quota. Modelling changes in population size suggest that the eastern Hudson Bay population has declined markedly during the past 5 years, possibly to as low as 1,100 (SE=500) animals. If current harvest levels continue then the lower 95% confidence limit suggests that this population could be extirpated as early as 2003. A reduction in harvests to 40 animals would be sustainable. A harvest of 20 animals would likely allow the herd to increase at a rate of 2% per year. However, there is considerable uncertainty associated with modelling estimates owing to a lack of population survey information, uncertainty associated with beluga population parameters, stock composition of beluga harvests in Hudson Strait, the proportion of animals visible at the surface during aerial surveys and under-reporting of harvests.

Discussion:

The author noted that the correction factor for submerged animals in the working paper (2.66) is incorrect. He reworked the calculations with a correction factor of 2.09 (based on

work on St. Lawrence belugas by Gauthier 1999) prior to his presentation, and will use this factor in revisions.

Concern was expressed about James Bay population estimates (whether they are too high), and about whether the model should assume (as it does presently) that the population is growing. It was suggested that there are insufficient data to recommend that the hunt be re-directed to James Bay, and general consensus that the recommendation should be removed from the final document.

In view of the previous point the author proposed that the analysis of the James Bay stock also be removed from the report. This opinion was endorsed by the committee.

The group agreed that the approach used throughout the study accurately captured the most current stock structure information from genetic analyses.

Concern was expressed that the methodologies used in the 1985 and 1993 surveys differed, and that the 1985 survey may have significantly underestimated the population—suggesting that the decline is greater than presently presented. At the least, the uncertainty arising from this factor should be described in the paper, and it should be noted that evidence for the decline does not rest solely on the aerial surveys, but on changes in the average ages of harvested animals and on changes in the use of estuaries by belugas.

There was strong consensus that a new census should be given high priority, and that genetic sampling should conducted on belugas from the Nelson River to James Bay. It was suggested that additional methods of detecting population segregation should be considered, such as the analysis of contaminant profiles and satellite telemetry. However, there was also concern that such alternative approaches could divert funds from the present research, and should only be proposed after careful consideration.

There was discussion about whether a greater range of r_{max} should be used than the 2-4% used in the paper. The author responded that he had explored r_{max} values up to 6% and that they did not affect the behaviour of the model significantly. He felt that it was unlikely that r_{max} was less than that of killer whales, and therefore that it was unreasonable to go below 2%. It was noted that the author's calculations were consistent with those of Dr. Kingsley, who provided review of this paper by email.

It was recommended that the discussion be revised to make it clear that current harvest levels are likely unsustainable not only in nearshore and estuarine areas, but throughout the entire study area.

9. An Evaluation of Steller Sea Lion (*Eumetopias jubatus*) Pup Counts from 35 mm Oblique Photographs. By P.F. Olesiuk, D.G. Calkins, K.W. Pitcher and W.L. Perryman. Working Paper #9.

Presenter: P. F. Olesiuk
Rapporteur: Lance Barrett-Lennard

Summary:

The precision and accuracy of Steller sea lion (*Eumetopias jubatus*) pup counts from 35mm oblique aerial photographs was assessed by comparing them to ground drive-counts and counts from vertical medium-format photographs. DFO flew 35mm aerial surveys within 2 days of the Alaska Department of Fish and Game's ground drive-counts at Forrester Island, Alaska, in 1994, 1995, 1997 and 1998. In 1998, all rookeries in British Columbia were surveyed twice, once using 35mm oblique photography and again using a vertical medium-format system developed at the Southwest Fisheries Science Centre of the U.S. National Marine Fisheries Service, which in an earlier assessment was shown to provide pup counts that were statistically equivalent to ground counts (Snyder et al. 2001). Ground drive-counts provided the most precise counts (*CV*=0.047) and are also widely regarded as the most accurate by which other methods are usually judged. Although vertical medium-format images were found to provide equally precise counts on Alaskan rookeries (*CV*=0.048; Snyder et al. 2001), the medium-format counts were not as precise for B.C. rookeries (*CV*=0.098) because one reader obtained counts that were consistently (8 of 10 sites) and significantly higher ($0.0001<P<0.0089$) than the other reader. Counts made from oblique 35mm slides were reproducible among readers (*CV*=0.089) and for surveys repeated on different dates (*CV*=0.061), but appeared to be biased. Comparisons at Forrester Island indicated that 35mm counts were significantly lower that drive-counts ($0.0001<P<0.0326$), with only about 80% of the pups counted on the ground being evident in the 35mm slides. The degree of bias seemed relatively constant on a site-by-site basis (slope=0.80 with *SE*=0.044) and between years (range 75.7-85.1%). Comparison of the 35mm with medium-format counts was somewhat confounded by the discrepancy between the two readers. For B.C. rookeries, we found no significant differences between the 35mm and medium-format counts, which was surprising given the significant differences between 35mm and ground counts at Forrester Island and the equivalency of medium-format and ground counts on Alaskan rookeries. The inability to detect any difference may have been attributable to the reduced power resulting from the imprecision introduced by the disparity in medium-format counts among the two readers. When the 35mm and medium-format surveys conducted at Forrester Island in 1997 and 1998 were included in the comparison, the 35mm counts were found to be significantly lower ($0.0003<P<0.0340$), with only about 83-86% of the pups counted on the medium-format images being evident in the 35mm slides. In order to resolve these somewhat ambiguous results, it is recommended that the medium-format images for B.C. rookeries be independently counted by a third reader, and that the 35mm and medium-format comparison be repeated during the next range-wide survey scheduled in 2002. In the interim, a correction ranging from 1 to 1.25 should be applied to pup counts made from oblique 35mm slides to account for missed animals.

Discussion:

The review group was in consensus that the paper was a valuable contribution, and expressed no significant concerns regarding the methodology.

The greatest difficulty in drawing conclusions from the paper arises from the significant differences in counts on the medium format pictures arrived at by two readers. The author acknowledges this difficulty and recommended in the working paper that a third, independent reader repeat the analysis of the pictures. This recommendation was endorsed by the review committee.

The review committee had some difficulty with the recommendation in the working paper that a correction factor of up to 1.25 be applied to counts from 35 mm slides to account for pups that may have been missed. The author pointed out that until the discrepancy between readers is resolved (and a more precise correction factor calculated), that upper and lower bounds should be placed on pup production using correction factors of 1.25 and 1.

It was recommended that the conclusion that the ground drive-counts "should not be considered until such time as their impact has been assessed" should be revised to the state that drive-counts not be considered at all. Two additional changes were suggested: that the conclusions include recommendations that at least two readers be used in future surveys and that all survey photographs be archived. The author was in agreement with all three proposed changes.

The review committee recommended that the working paper be upgraded to a research document. While it would be desirable to resolve the discrepancy between readers, this shouldn't delay the publication of the paper as a Research Document.

10. Recent Trends in the Abundance of Steller Sea Lions (*Eumetopias jubatus*) in British Columbia. By P.F. Olesiuk. Working Paper #10.

Presenter: P. F. Olesiuk
Rapporteur: Lance Barrett-Lennard

Summary:

Recent trends in the abundance of Steller sea lions (*Eumetopias jubatus*) in British Columbia were examined based on a series of 8 province-wide aerial surveys conducted during the breeding season (27-June to 04-July) in 1971-1998. On rookeries, abundance of both pups and non-pups increased at a rate of 2.2% per annum, which has resulted in a doubling of numbers since the species was protected in 1970. Total numbers of non-pups observed on rookeries and haulout sites also increased at a rate of 2.9%, which was slightly faster than the breeding population probably due to a greater prevalence of non-breeding animals associated with rookeries in SE Alaska. In the most recent survey in 1998, we counted 2,073 pups on rookeries and 9,818 non-pups (4,398 on rookeries and 5,420 on haulouts). Based on current pup production and life table statistics (Calkins and Pitcher 1982), it was estimated that roughly 13,400 -18,800 Steller sea lions currently inhabit coastal water of B.C. during the breeding season (which includes surplus non-breeding animals associated with rookeries in SE Alaska). A review of historic data (Bigg 1985) indicated that control

programs and commercial harvests during 1912-1967 had eradicated one rookery and reduced breeding populations to about 30% of levels reported when the first assessment was made in 1913. Abundance of Steller sea lions in SE Alaska has also increased in recent years, where 3 new rookeries have been established, including what is now the largest rookery just a few kilometres north of the B.C.-Alaska border (Calkins et al. 1999). These recent increases likely represent the recovery of populations from control programs and harvests, but abundance now appears to have attained peak historic peak levels. Given the recent declines in abundance of Steller sea lions in the Gulf of Alaska and Bering Sea, which have been designated as *endangered*, and since the species appears to be a good indicator of ecosystem status, it is recommended that the B.C. surveys be continued on a regular basis as part of the range-wide surveys every 4 years, the next of which is scheduled in 2002.

Discussion:

The committee suggested that the description of the classification of haulout sites should be moved from results to methods section.

There was discussion of the use of correction factors for comparing contemporary counts from 35mm aerial surveys and historic counts made from boats and land. The author agreed to apply correction factors to the aerial pup counts in the historic comparison (Figure 10).

The author agreed that figure 9 was redundant and should be dropped, likewise consideration should be given to dropping Figure 7.

The committee observed that the discussion contains two references to the use of Steller sea lions as indicator species of environmental change, which may overstate the case somewhat.

The committee felt that the final recommendation (not endangered), while likely true, doesn't belong in this paper.

The committee was in agreement that a report on the status of Steller sea lions should be prepared. There was a discussion of whether the report should include pup counts from SE Alaska. There was consensus that counts from 3 rookeries in SE Alaska (Forester, Hazy and White Sisters) should be included.

The committee felt that the reference to carrying capacity in the second recommendation should be changed to "historic levels" since there is no consensus about whether the population is presently (or was historically) at carrying capacity or whether carrying capacity is constant over time.

It was agreed that Recommendation two would be better treated as part of the discussion.

The committee recommended that the paper be upgraded to a research document.

Day 3 – Afternoon Discussion

Chairman's note: Mike Hammill presented a first draft of the Northern Quebec Stock Status Report. This report summarized the main conclusions of those working papers dealing with

the beluga of Eastern Hudson Bay/Northern Quebec. A number of revisions were suggested by the review committee. It was agreed that a second draft of the SSR would be prepared and circulated to the review committee for finalization shortly after the meeting.

Day 4 – Morning Discussions

DISCUSSION OF INFORMATIONAL ITEMS

Chairman's note: As planned, the committee now moved out of formal review mode, and considered several papers that were provided for information and discussion. Since the papers that were presented were works in progress, no working paper number is assigned to them, nor are summaries provided.

P.R. Richard. -- Adaptive sampling for large marine animal surveys

Pierre Richard presented the design of adaptive sampling, which consists in leaving a transect to survey more intensively a concentration of animals when a threshold number of individuals are encountered on a transect. He suggested that this approach be used in the context of large scale surveys of marine animals that are clumped in distribution. The advantage of such a design over stratification would reside into its mobile nature. However, there are obvious problems with adaptive sampling when you target multiple species.

It was pointed out that this approach is already used to survey several species of marine mammals, including harp seals, hooded seals and killer whales.

A list of questions regarding a large scale multi-species marine mammal survey were submitted to the committee by Kaija Metuzals of the Biodiversity Science Branch in Ottawa. There was a consensus that the role of this committee is to peer review the results of such surveys and not providing views on their design. The most effective design of a large scale survey should be discussed among international experts as part of a separate meeting (workshop). The committee felt that it was unlikely that there exists a survey design that can accommodate and provide good information on all of the species.

D. Bowen and A. Beck– Sequential location filter for cleaning ARGOS satellite positions

Don Bowen first presented a three-step filter to clean ARGOS satellite positions using a Visual Basic program.

There was a concern that the most interesting deviations from normal behaviour would be rejected by this filter. However, it was confirmed that this would not be the case, unless the position resulted in biologically unfeasible velocities.

Don Bowen then presented a method for obtaining relatively precise locations from TDR-equipped animals using geolocation information, dive depth, bathymetry and surface temperature. It was generally agreed that this approach, although it may be of limited use when examining short-scale movements, can provide useful information on the meso-scale and large-scale movements of marine animals.

S. Iverson et al. – Update on the development of a zonal fatty acid signature library

D. Bowen presented an overview of the number of prey that were analysed to date for the Gulf of St Lawrence and Scotian Shelf, and illustrated their usefulness in determining the diet of predators. His presentation clearly indicated that the marine fish species differ in their fatty acid signatures, and that within species, specimens from different size classes or location can be discriminated on the basis of their fatty acid profiles.

A few questions were raised concerning the half-life of fatty acids and the effect of a change in diet, or of fasting, on fatty acid signatures. Studies in captivity suggest that fatty acid signatures are quite robust to fasting, and that the fatty acid profile of a predator changes relatively rapidly to reflect the current diet, although it represents a mixture of the new and older diet.

There is a stratification of the fatty acid profiles in the blubber of some marine mammals. Therefore, it was concluded that a better understanding of how the fatty acids are deposited in the blubber is necessary in order to exploit fully this technique.

S. Cosens. Distribution of hunting effort of bowhead whales in eastern Arctic

No clear agreement was reached as to how the hunting effort should be distributed between the northern Foxe Basin, where most of the animals are females with young, and the northern Hudson Bay.

It was suggested that the model of P. Richard be used to study the issue in more detail. However, it was also pointed out that because existing models do not incorporate information on the mating strategy and hence reproductive contribution of males, the models would not be useful for assessing the relative impact of male and female removals.

CLOSING REMARKS

The chairman thanked all participants for their contribution to the meeting. It was noted that participants would receive copies of the papers presented at the meeting after they are published in the Canadian Stock Assessment Secretariat Research Document Series. The meeting adjourned at 12h00 on March 2, 2001.

Annex 1. List of Participants

Participant	E-Mail Address	Fax Number
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Annex 2. Working Paper Titles and Terms of Reference

Papers for Peer Review

WP Title	Authors	TORs For Review	SSR
Introduction to EHB Beluga working papers	M. Hammill		
Stock discrimination of belugas (*Delphinapterus leucas*) collected between 1984 and 1997, from Sanikiluaq (Belcher Islands) and Eastern Hudson Bay by mitochondrial DNA and 15 nuclear microsatellite loci	B.G.E. de March., L.D. Maiers, Hammill, M and Doidge, D.W.	Review genetic evidence that there consisten differences between Eastern Hudson Bay beluga and Sanikiluaq Islands. Examine conclusions on the source of migrating belugas harvested in Northern Quebec. (to be confirmed)	Status of EHB Beluga
Harvest statistics for beluga whales in Nunavik, 1974-2000	Lesage, V., Doidge, W.D., and Fibich, R.	Review spatial, seasonal and yearly patterns in beluga catch-at-age and total harvests	Status of EHB Beluga
Use of the Nastapoka Estuary by humans and belugas during summer 2000	Doidge, D.W.		Status of EHB Beluga
Implications of different estimates of longevity of belugas and narwhals on sustainability	Richard, P.R.	The peer review should focus on the appropriateness of the population dynamics model and assumptions used to compare the impact of longevity on sustainability	Status of EHB Beluga
Eastern Hudson Bay Beluga Precautionary Approach Case Study	Richard, P.R., Power, M. and M. Hammill	Appropriateness of the choice of model, model assumptions and risk assessment in the context of it use as a discussion tool for Co-Management Precautionary Approach workshops.	Status of EHB Beluga
Beluga in Northern Quebec: impact of harvesting on population trends of beluga in eastern Hudson Bay and James Bay	Hammill, M.O.	Review scientific basis for short-term management recommendations for Eastern Hudson Bay, including the impacts of different mixing rates with adjacent beluga populations	Status of EHB Beluga
Population Index Estimate for the Belugas of the St. Lawrence in 2000	Gosselin, J.-F., Lesage, V., and Robillard, A.	Evaluate the index estimate for 2000, and population trends	None planned

Population structure and genetic Variability in north-eastern Pacific killer whales: towards an assessment of population viability.	Barrett-Lennard, L.	Evaluate conclusions regarding population structure and factors affecting the maintenance of genetic variability, specifically dispersal and mating systems.	None planned
An evaluation of Steller sea lion (Eumetopias jubatus) pup counts using 35mm oblique photography	Olesiuk, P.F., D.G. Calkins, K.W. Pitcher and W.L. Perryman..	The paper evaluates the accuracy of pup counts made from 35mm oblique photographs, the procedure by which Steller sea lions have been surveyed in B.C. since the early 1970s, by comparing 35mm counts with ground drive counts (on a neighboring rookery in Alaska) and medium-format vertical photographs (B.C. rookeries). These comparisons indicate that 35mm counts underestimate pup abundance by 10-20%, but since the bias appears to be consistent among sites and years the 35mm counts are considered to be a good index. The review committee should examine the method used for the comparison and statistical analysis, and comment on the validity of pup counts and Correction factors to adjust for the bias.	None planned
Recent trends in the abundance of Steller sea lions *(Eumetopias jubatus)* in British Columbia.	Olesiuk, P.F.	The paper describes Steller population trends based on series of surveys conducted at about 5-year intervals from the early 1970s to late 1990s. Population trends are estimated based on total counts, rookery counts, and pup production (corrected for undercounting). Actual abundance is estimated based on corrected number of pups and expected ratio of pups:non-pups based on life table analysis. The review committee should examine survey procedures and comment on the validity of the trend analysis and procedure used to estimate abundance.	

Papers for the Information of the NMMRC, and for their Discussion and Recommendations

WP Title	Authors	Background
Adaptive Sampling for Large Marine Animal Surveys	Richard, P.R.	The paper will discuss the appropriateness of the choice of sampling design in the context of single-species and multispecies surveys of marine animals. It is meant to provide background to a more general discussion for large marine animal surveys.
Scotian Shelf grey seal population distribution and foraging based on satellite tag and geo-location time-depth recorders	Bowen, D.	
Update on the Development of a Zonal Fatty Acid Signature Library and How This Will Be Used to Generate New Estimates of Diet	Bowen, D.	

Annex 3. Agenda, NMMRC Winnipeg Feb 27 – Mar 02, 2001.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
	Feb. 26	Feb. 27	Feb. 28	Mar. 1	Mar. 2
09:00 - 09:30		Call to Order, Introductions, Rapporteurs			
09:30 - 10:00			Eastern Hudson Bay/NQ Belugas	Steller's Sea Lion	Informational Items
10:00 - 10:30					
10:30- 11:00		Killer Whale Population Structure			
11:00 - 11:30					
11:30 - 12:00					Adjourn
		Lunch	Lunch	Lunch	Lunch
13:00 - 13:30			(next item needs		
13:30 - 14:00			2 h, may have xtra		
14:00 - 14:30		Eastern	Time Here		
14:30 - 15:00		Hudson Bay/NQ	For Other Beluga	SSR Review	
15:00 - 15:30		Belugas	Stocks)		
15:30 - 16:00			St. Lawrence		
16:00 - 16:30			Belugas		
16:30 - 17:00					

Annex 4: Photograph of participants

(Photo Credit: Jack Orr)

Meeting Attendees: (front row, from left to right) Brian Wong, Sue Cosens, Lena Measures, Ted Miller, Mike Hammill, Andrew Trites, Brigitte de March, Véronique Lesage, Bill Doidge. (back row, from left to right) Jean-François Gosselin, Rob Stewart, John Neilson, Pierre Richard, Don Bowen, Lance Barrett-Lennard, Patrice Simon, Peter Olesiuk.

Absent at time of photograph: Burton Ayles, Okalik Eegeesiak, Robert Michaud, Larry Dueck.